WHAT IS CLAIMED IS:

1. A data storage and retrieval system for storing information on, and retrieving information from, a three-dimensional fluorescent photosensitive optical memory, said system comprising:

(a) a first coherent light beam generator for generating a first coherent light beam;

(b) a second coherent light beam generator for generating a second coherent light beam; and

(c) an optical positioning system for directing said first coherent light beam and said second coherent light beam to irradiate an individually selected volume of said optical memory to produce a change in fluorescence characteristics in said selected volume.

2. The data storage and retrieval system according to claim 1 wherein said first coherent light beam generator is a first laser.

3. The data storage and retrieval system according to claim 2 wherein said first laser is a Ti:sapphire laser.

4. The data storage and retrieval system according to claim 2 wherein said first laser is a pulse laser.

5. The data storage and retrieval system according to claim 1 wherein said second coherent light beam generator is a second laser.

6. The data storage and retrieval system according to claim 5 wherein said second laser is a Ti:sapphire laser.

7. The data storage and retrieval system according to claim 5 wherein said second laser is a pulse laser.

8. The data storage and retrieval system according to claim 1 wherein said first coherent beam generator irradiates said individually selected volume of said optical memory with said first coherent light beam at a first predetermined writing wavelength and said second coherent beam generator irradiates said individually selected volume of optical memory with said second coherent light beam at a second predetermined writing wavelength; wherein said first coherent light beam and said second coherent light beam cause a change in fluorescence characteristics in said selected volume.

9. The data storage and retrieval system according to claim 1 further comprising an optical focusing system for focusing said first coherent light beam and said second coherent light beam on said optical memory.

10. The data storage and retrieval system according to claim 9 wherein said optical focusing system comprises a confocal microscope.

11. The data storage and retrieval system according to claim 1 wherein said optical positioning system further comprises a vertical scanning system to

position said first coherent light beam and said second coherent light beam along a vertical axis of said optical memory.

12. The data storage and retrieval system according to claim 1 wherein said optical positioning system further comprises a radial scanning system to position said first coherent light beam and said second coherent light beam along a radial axis of said optical memory.

13. The data storage and retrieval system according to claim 1 further comprising a reading system for reading information from said optical memory, said reading system comprising:

(a) a first reading light beam generator for generating a first reading light beam to excite at least an individually selected volume of said optical memory with said first reading light beam at a first predetermined reading wavelength;

(b) a second reading light beam generator for generating a second reading light beam to excite at least said individually selected volume of optical memory with said second reading light beam at a second predetermined reading wavelength; and

(c) a detector for detecting fluorescence in at least said individually selected volume.

14. The data storage and retrieval system according to claim 13 wherein said first reading light beam generator is a first coherent light beam generator.

15. The data storage and retrieval system according to claim 14 wherein said first coherent light beam generator is a first laser.

16. The data storage and retrieval system according to claim 15 wherein said first laser is a Ti:sapphire laser.

17. The data storage and retrieval system according to claim 15 wherein said first laser is a pulse laser.

18. The data storage and retrieval system according to claim 13 wherein said second reading light beam generator is a second coherent light beam generator.

19. The data storage and retrieval system according to claim 18 wherein said second coherent light beam generator is a second laser.

20. The data storage and retrieval system according to claim 19 wherein said second laser is a Ti:sapphire laser.

21. The data storage and retrieval system according to claim 19 wherein said second laser is a pulse laser.

22. The data storage and retrieval system according to claim 13 further comprising an optical focusing system for focusing said first reading light beam and said second reading light beam on said individually selected volume of said optical memory.

23. The data storage and retrieval system according to claim 22 wherein said optical focusing system comprises a confocal microscope.

24. The data storage and retrieval system according to claim 13 further comprising a vertical scanning system to position said first reading light beam and said second reading light beam along a vertical axis of said optical memory.

25. The data storage and retrieval system according to claim 13 further comprising a radial scanning system to position said first reading light beam and said second reading light beam along a radial axis of said optical memory.

26. The data storage and retrieval system according to claim 1, wherein said fluorescent photosensitive memory comprises glass, said glass comprises two or more rare earths, at least one of said two or more rare earths is selected from the group consisting of ytterbium (Yb), samarium (Sm), and combinations thereof; and at least one of said two or more rare earths is selected from a group consisting of erbium (Er), thulium (Tm), ytterbium (Yb), holmium (Ho), samarium (Sm), dysprosium (Dy), terbium (Tb), neodymium (Nd) and combinations thereof.

27. The data storage and retrieval system according to claim 26 wherein said glass further comprises about 10 mole percent to about 80 mole percent SiO_2, up to about 54 mole percent K_2O, up to about 58 mole percent Na_2O, up to about 35 mole percent Li_2O, up to about 40 mole percent BaO, up to about 40

mole percent SrO, up to about 56 mole percent CaO, up to about 42 mole percent MgO, up to about 48 mole percent ZnO and up to about 5 mole percent of said two or more rare earths in oxide form.

28. The data storage and retrieval system according to claim 26 wherein said glass further comprises about 20 mole percent to about 80 mole percent P_2O_5, up to about 47 mole percent K_2O, up to about 60 mole percent Na_2O, up to about 60 mole percent Li_2O, up to about 58 mole percent BaO, up to about 56 mole percent SrO, up to about 56 mole percent CaO, up to about 60 mole percent MgO, up to about 64 mole percent ZnO, up to about 5 mole percent yttrium (Y), and up to about 5 mole percent of said two or more rare earths in oxide form.

29. The data storage and retrieval system according to claim 1, wherein said fluorescent photosensitive memory comprises vitroceramic, said vitroceramic comprises one or more photosensitizing metals selected from the group consisting of gold (Au), copper (Cu) and combinations thereof; and one or more rare earths selected from the group consisting of praseodymium (Pr), dysprosium (Dy), erbium (Er), holmium (Ho), europium (Eu), thulium (Tm) and combinations thereof.

30. The data storage and retrieval system according to claim 29, wherein said vitroceramic further comprises, in mole percent, about 10% to about 60% SiO_2, about 5% to about 60% PbF_2, about 0.05% to about 0.3% Sb_2O_3, up to about 0.5% CeO_2, up to about 60% CdF_2, up to about 30% GeO_2, up to about 10% TiO_2, up to

about 10% ZrO_2, up to about 40% Al_2O_3, up to about 40% Ga_2O_3, and about 10% to about 30% $Ln1F_3$ where Ln1 is selected from the group consisting of yttrium (Y) and ytterbium (Yb).

31. The data storage and retrieval system according to claim 30, wherein said Ln1 comprises ytterbium (Yb) and said Ln2 is selected from the group consisting of Er, Ho, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident infrared radiation into visible light.

32. The data storage and retrieval system according to claim 30, wherein said Ln1 comprises yttrium (Y) and said Ln2 is selected from the group consisting of Pr, Dy, Ho, Er, Eu, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident ultraviolet light into visible light.

33. A data retrieval system for reading information from a three-dimensional fluorescent photosensitive optical memory, said retrieval system comprising:

(a) a first reading light beam generator for generating a first reading light beam to excite at least an individually selected volume of said optical memory with said first reading light beam at a first predetermined reading wavelength;

(b) a second reading light beam generator for generating a second reading light beam to excite at least said individually selected volume of said optical memory with said second reading light beam at a second predetermined wavelength; and

(c) a detector for detecting fluorescence in at least said individually selected volume.

34. The data retrieval system according to claim 33 wherein said first reading light beam generator is a first coherent light beam generator.

35. The data retrieval system according to claim 34 wherein said first coherent light beam generator is a first laser.

36. The data retrieval system according to claim 35 wherein said first laser is a Ti:sapphire laser.

37. The data retrieval system according to claim 35 wherein said first laser is a pulse laser.

38. The data retrieval system according to claim 33 wherein said second reading light beam generator is a second coherent light beam generator.

39. The data retrieval system according to claim 38 wherein said second coherent light beam generator is a second laser.

40. The data retrieval system according to claim 39 wherein said second laser is a Ti:sapphire laser.

41. The data retrieval system according to claim 39 wherein said second laser is a pulse laser.

42. The data retrieval system according to claim 33 further comprising an optical focusing system for focusing said first reading light beam and said second reading light beam on said individually selected volume of said optical memory.

43. The data retrieval system according to claim 42 wherein said optical focusing system comprises a confocal microscope.

44. The data retrieval system according to claim 33 further comprising a vertical scanning system to position said first reading light beam and said second reading light beam along a vertical axis of said optical memory.

45. The data retrieval system according to claim 33 further comprising a radial scanning system to position said first reading light beam and said second reading light beam along a radial axis of said optical memory.

46. The data retrieval system according to claim 33, wherein said fluorescent photosensitive memory comprises glass, said glass comprises two or more rare earths, at least one of said two or more rare earths is selected from the group consisting of ytterbium (Yb), samarium (Sm), and combinations thereof; and at least one of said two or more rare earths is selected from a group consisting of erbium (Er), thulium (Tm), ytterbium (Yb), holmium (Ho), samarium (Sm), dysprosium (Dy), terbium (Tb), neodymium (Nd) and combinations thereof.

47. The data retrieval system according to claim 46, wherein said glass further comprises about 10 mole percent to about 80 mole percent SiO_2, up to about 54 mole percent K_2O, up to about 58 mole percent Na_2O, up to about 35 mole percent Li_2O, up to about 40 mole percent BaO, up to about 40 mole percent SrO, up to about 56 mole percent CaO, up to about 42 mole percent MgO, up to about 48 mole percent ZnO and up to about 5 mole percent of said two or more rare earths in oxide form.

48. The data retrieval system according to claim 46, wherein said glass further comprises about 20 mole percent to about 80 mole percent P_2O_5, up to about 47 mole percent K_2O, up to about 60 mole percent Na_2O, up to about 60 mole percent Li_2O, up to about 58 mole percent BaO, up to about 56 mole percent SrO, up to about 56 mole percent CaO, up to about 60 mole percent MgO, up to about 64 mole percent ZnO, up to about 5 mole percent yttrium (Y), and up to about 5 mole percent of said two or more rare earths in oxide form.

49. The data retrieval system according to claim 33, wherein said fluorescent photosensitive memory comprises vitroceramic, said vitroceramic comprises one or more photosensitizing metals selected from the group consisting of gold (Au), copper (Cu) and combinations thereof; and one or more rare earths selected from the group consisting of praseodymium (Pr), dysprosium (Dy), erbium (Er), holmium (Ho), europium (Eu), thulium (Tm) and combinations thereof.

50. The data retrieval system according to claim 49, wherein said vitroceramic further comprises,

in mole percent, about 10% to about 60% SiO_2, about 5% to about 60% PbF_2, about 0.05% to about 0.3% Sb_2O_3, up to about 0.5% CeO_2, up to about 60% CdF_2, up to about 30% GeO_2, up to about 10% TiO_2, up to about 10% ZrO_2, up to about 40% Al_2O_3, up to about 40% Ga_2O_3, and about 10% to about 30% $Ln1F_3$ where Ln1 is selected from the group consisting of yttrium (Y) and ytterbium (Yb).

51. The data retrieval system according to claim 50, wherein said Ln1 comprises ytterbium (Yb) and said Ln2 is selected from the group consisting of Er, Ho, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident infrared radiation into visible light.

52. The data retrieval system according to claim 50, wherein said Ln1 comprises yttrium (Y) and said Ln2 is selected from the group consisting of Pr, Dy, Ho, Er, Eu, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident ultraviolet light into visible light.

53. A data retrieval system for reading information from a three-dimensional fluorescent photosensitive optical memory, said retrieval system comprising:

(a) a first reading light beam generator for generating a reading light beam to excite a volumetric slice of said optical memory with said reading light beam at a first predetermined reading wavelength, said volumetric slice including multiple individual volumes; and

(b) a detector for detecting fluorescence in at least said individually selected volume.

54. The data retrieval system according to claim 53 wherein said reading light beam generator is a first coherent light beam generator.

55. The data retrieval system according to claim 54 wherein said coherent light beam generator is a laser.

56. The date retrieval system according to claim 55 wherein said laser is a Ti:sapphire laser.

57. The date retrieval system according to claim 55 wherein said laser is a pulse laser.

58. The data retrieval system according to claim 53 further comprising a radial scanning system to position said detector along a radial axis of said optical memory.

59. The data retrieval system according to claim 53 further comprising a vertical scanning system to position said reading light beam along a vertical axis of said optical memory.

60. The data retrieval system according to claim 53, wherein said fluorescent photosensitive material comprises glass, said glass comprises two or more rare earths, at least one of said two or more rare earths is selected from the group consisting of ytterbium (Yb), samarium (Sm), and combinations

thereof; and at least one of said two or more rare earths is selected from a group consisting of erbium (Er), thulium (Tm), ytterbium (Yb), holmium (Ho), samarium (Sm), dysprosium (Dy), terbium (Tb), neodymium (Nd) and combinations thereof.

61. The data retrieval system according to claim 60, wherein said glass further comprises about 10 mole percent to about 80 mole percent SiO_2, up to about 54 mole percent K_2O, up to about 58 mole percent Na_2O, up to about 35 mole percent Li_2O, up to about 40 mole percent BaO, up to about 40 mole percent SrO, up to about 56 mole percent CaO, up to about 42 mole percent MgO, up to about 48 mole percent ZnO and up to about 5 mole percent of said two or more rare earths in oxide form.

62. The data retrieval system according to claim 60, wherein said glass further comprises about 20 mole percent to about 80 mole percent P_2O_5, up to about 47 mole percent K_2O, up to about 60 mole percent Na_2O, up to about 60 mole percent Li_2O, up to about 58 mole percent BaO, up to about 56 mole percent SrO, up to about 56 mole percent CaO, up to about 60 mole percent MgO, up to about 64 mole percent ZnO, up to about 5 mole percent yttrium (Y), and up to about 5 mole percent of said two or more rare earths in oxide form.

63. The data retrieval system according to claim 53, wherein said fluorescent photosensitive material comprises vitroceramic, said vitroceramic comprises one or more photosensitizing metals selected from the group consisting of gold (Au), copper (Cu) and combinations thereof; and one or more rare earths

selected from the group consisting of praseodymium (Pr), dysprosium (Dy), erbium (Er), holmium (Ho), europium (Eu), thulium (Tm) and combinations thereof.

64. The data retrieval system according to claim 63, wherein said vitroceramic further comprises, in mole percent, about 10% to about 60% SiO_2, about 5% to about 60% PbF_2, about 0.05% to about 0.3% Sb_2O_3, up to about 0.5% CeO_2, up to about 60% CdF_2, up to about 30% GeO_2, up to about 10% TiO_2, up to about 10% ZrO_2, up to about 40% Al_2O_3, up to about 40% Ga_2O_3, and about 10% to about 30% $Ln1F_3$ where Ln1 is selected from the group consisting of yttrium (Y) and ytterbium (Yb).

65. The data retrieval system according to claim 64, wherein said Ln1 comprises ytterbium (Yb) and said Ln2 is selected from the group consisting of Er, Ho, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident infrared radiation into visible light.

66. The data retrieval system according to claim 64, wherein said Ln1 comprises yttrium (Y) and said Ln2 is selected from the group consisting of Pr, Dy, Ho, Er, Eu, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident ultraviolet light into visible light.

67. A method for retrieving data from a fluorescent photosensitive three-dimensional optical memory, said method comprising:

(a) generating a first reading light beam;

(b) generating a second reading light beam;

(c) exciting at least an individually selected volume of said optical memory with said first reading light beam at a first predetermined reading wavelength and said second reading light beam at a second predetermined reading wavelength; and

(d) detecting fluorescence in at least said individually selected volume.

68. The method for retrieving data according to claim 67 further comprising generating said first reading light beam from a first coherent light beam generator.

69. The method for retrieving data according to claim 68 comprising generating said first reading light beam from a first laser.

70. The method for retrieving data according to claim 69 comprising generating said first reading light beam from a Ti:sapphire laser.

71. The method for retrieving data according to claim 69 comprising generating said first reading light beam from a pulse laser.

72. The method for retrieving data according to claim 67 comprising detecting fluorescence in at least said individually selected volume using a detector.

73. The method for retrieving data according to claim 67 further comprising generating said second

reading light beam from a second coherent light beam generator.

74. The method for retrieving data according to claim 73 comprising generating said second reading light beam from a second laser.

75. The method for retrieving data according to claim 74 comprising generating said second reading light beam from a Ti:sapphire laser.

76. The method for retrieving data according to claim 74 comprising generating said second reading light beam from a pulse laser.

77. The method for retrieving data according to claim 67 further comprising focusing said first reading light beam and said second reading light beam on said optical memory.

78. The method for retrieving data according to claim 77 wherein said focusing further comprises using a confocal microscope.

79. The method for retrieving data according to claim 67 further comprising positioning said first reading light beam and said second reading light beam along a vertical axis of said optical memory using a vertical scanning system.

80. The method for retrieving data according to claim 67 further comprising positioning said first reading light beam and said second reading light beam

along a radial axis of said optical memory using a radial scanning system.

81. The method for retrieving data according to claim 67, comprising providing a fluorescent photosensitive memory comprising glass, said glass comprising using two or more rare earths, selecting at least one of said two or more rare earths from the group consisting of ytterbium (Yb), samarium (Sm), and combinations thereof; and selecting at least one of said two or more rare earths from a group consisting of erbium (Er), thulium (Tm) ytterbium (Yb), holmium (Ho), samarium (Sm), dysprosium (Dy), terbium (Tb), neodymium (Nd) and combinations thereof.

82. The method for retrieving data according to claim 81, comprising using glass further comprising about 10 mole percent to about 80 mole percent SiO_2, up to about 54 mole percent K_2O, up to about 58 mole percent Na_2O, up to about 35 mole percent Li_2O, up to about 40 mole percent BaO, up to about 40 mole percent SrO, up to about 56 mole percent CaO, up to about 42 mole percent MgO, up to about 48 mole percent ZnO and up to about 5 mole percent of said two or more rare earths in oxide form.

83. The method for retrieving data according to claim 81, comprising using glass further comprising about 20 mole percent to about 80 mole percent P_2O_5, up to about 47 mole percent K_2O, up to about 60 mole percent Na_2O, up to about 60 mole percent Li_2O, up to about 58 mole percent BaO, up to about 56 mole percent SrO, up to about 56 mole percent CaO, up to about 60 mole percent MgO, up to about 64 mole percent ZnO, up

to about 5 mole percent yttrium (Y), and up to about 5 mole percent of said two or more rare earths in oxide form.

84. The method for retrieving data according to claim 67, comprising providing a fluorescent photosensitive memory comprising vitroceramic, said vitroceramic comprising using one or more photosensitizing metals and one or more rare earths, selecting one or more said photosensitizing metals from the group consisting of gold (Au), copper (Cu) and combinations thereof; and selecting one or more said rare earths from the group consisting of praseodymium (Pr), dysprosium (Dy), erbium (Er), holmium (Ho), europium (Eu), thulium (Tm) and combinations thereof.

85. The method for retrieving data according to claim 84, comprising using said vitroceramic further comprising, in mole percent, about 10% to about 60% SiO_2, about 5% to about 60% PbF_2, about 0.05% to about 0.3% Sb_2O_3, up to about 0.5% CeO_2, up to about 60% CdF_2, up to about 30% GeO_2, up to about 10% TiO_2, up to about 10% ZrO_2, up to about 40% Al_2O_3, up to about 40% Ga_2O_3, and about 10% to about 30% $Ln1F_3$ where Ln1 is selected from the group consisting of yttrium (Y) and ytterbium (Yb).

86. The method for retrieving data according to claim 85, comprising using vitroceramic wherein said Ln1 comprises ytterbium (Yb) and said Ln2 is selected from the group consisting of Er, Ho, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident infrared radiation into visible light.

87. The method for retrieving data according to claim 85, comprising using vitroceramic wherein said Ln1 comprises yttrium (Y) and said Ln2 is selected from the group consisting of Pr, Dy, Ho, Er, Eu, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident ultraviolet light into visible light.

88. A three-dimensional optical memory comprising fluorescent photosensitive glass, wherein said glass comprises at least one of two or more rare earths selected from the group consisting of ytterbium (Yb), samarium (Sm), and combinations thereof; and at least one of two or more rare earths selected from a group consisting of erbium (Er), thulium (Tm), ytterbium (Yb), holmium (Ho), samarium (Sm), dysprosium (Dy), terbium (Tb), neodymium (Nd) and combinations thereof.

89. The three-dimensional optical memory of fluorescent photosensitive glass according to claim 88 wherein said glass further comprises about 10 mole percent to about 80 mole percent SiO_2, up to about 54 mole percent K_2O, up to about 58 mole percent Na_2O, up to about 35 mole percent Li_2O, up to about 40 mole percent BaO, up to about 40 mole percent SrO, up to about 56 mole percent CaO, up to about 42 mole percent MgO, up to about 48 mole percent ZnO and up to about 5 mole percent of said two or more rare earths in oxide form.

90. The three-dimensional optical memory of fluorescent photosensitive glass according to claim 88 wherein said glass further comprises about 20 mole

percent to about 80 mole percent P_2O_5, up to about 47 mole percent K_2O, up to about 60 mole percent Na_2O, up to about 60 mole percent Li_2O, up to about 58 mole percent BaO, up to about 56 mole percent SrO, up to about 56 mole percent CaO, up to about 60 mole percent MgO, up to about 64 mole percent ZnO, up to about 5 mole percent yttrium (Y), and up to about 5 mole percent of said two or more rare earths in oxide form.

91. A three-dimensional optical memory comprising fluorescent photosensitive vitroceramic, wherein said vitroceramic comprises one or more photosensitizing metals and one or more rare earths, one or more photosensitizing metals is selected from the group consisting of gold (Au), copper (Cu) and combinations thereof; and one or more rare earths is selected from the group consisting of praseodymium (Pr), dysprosium (Dy), erbium (Er), holmium (Ho), europium (Eu), thulium (Tm) and combinations thereof.

92. The three-dimensional optical memory of fluorescent photosensitive vitroceramic according to claim 91 wherein said vitroceramic further comprises, in mole percent, about 10% to about 60% SiO_2, about 5% to about 60% PbF_2, about 0.05% to about 0.3% Sb_2O_3, up to about 0.5% CeO_2, up to about 60% CdF_2, up to about 30% GeO_2, up to about 10% TiO_2, up to about 10% ZrO_2, up to about 40% Al_2O_3, up to about 40% Ga_2O_3, and about 10% to about 30% $Ln1F_3$ where Ln1 is selected from the group consisting of yttrium (Y) and ytterbium (Yb).

93. The three-dimensional optical memory of fluorescent photosensitive vitroceramic according to claim 92 wherein said Ln1 comprises ytterbium (Yb) and

said Ln2 is selected from the group consisting of Er, Ho, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident infrared radiation into visible light.

94. The three-dimensional optical memory of fluorescent photosensitive vitroceramic according to claim 93 wherein said Ln1 comprises yttrium (Y) and said Ln2 is selected from the group consisting of Pr, Dy, Ho, Er, Eu, Tm and combinations thereof; whereby said vitroceramic is capable of converting incident ultraviolet light into visible light.